

**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5**

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SUBJECT: Preliminary Ecological Risk Assessment of Cosden Oil and Chemical Co., Calumet City, Illinois.

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US EPA RECORDS CENTER REGION 5



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The following report summarizes preliminary findings regarding potential ecological risk at the Cosden Oil and Chemical Co. Site (the site). The findings are based on the Expanded Site Inspection Final Report, Cosden Oil and Chemical Co., Calumet City, Illinois, prepared by an unidentified ARCS contractor, for the U.S. EPA, November 9, 1995, which is referred to as the ESI hereafter, and a perimeter site visit on 9/30/96. The objectives of this review are to identify ecological resources, and possible immediate or long term ecological threats the site may pose.

1. Problem Formulation

1.1 Environmental Setting

1.1.1 Site Description

The site is located on the south bank of the Little Calumet River between I-94 and Paxton Avenue. It is bound by the river on the north and B & O Railroad on the south. Industrial properties are located east and southwest of the site, and vacant land is located to the west and southeast. The CID Landfill is directly across the river. Beaubien Preserve, Cook County Forest Preserve District, is immediately downstream of the site on the opposite (north) bank, and has a public boat launch on the Little Calumet River.

1.1.2 Sensitive Habitats

Palustrine wetlands were identified from the Lake Calumet and Blue Island wetlands maps. A ditch along the south boundary of the site is classified as an emergent semipermanently flooded excavated wetland. An approximately 60- to 70-acre complex of forest and emergent vegetation wetlands is located directly west of the site, with approximately equal portions north and south of the railroad. The northern portion, which is closest to the site, has been partially drained or ditched and is seasonally or temporarily flooded. Most of the southern portion is semipermanently flooded, the remainder is seasonally flooded. The 9/30 site visit was performed to determine whether this wetland complex might receive runoff from the site via the southern ditch, which is shown extending west to I-94 in Fig. 2-2 of the ESI. The ditch is heavily vegetated with shrubs, grasses and weeds, and held standing water throughout most of its length adjacent to the site. However, it dried up before it reached I-94, and the ditch itself ends short of the I-94 overpass. No subsurface drains or culverts were located along the

western portion of the ditch, although the dense vegetation hampered the search. It appears that the ditch is unlikely to discharge to the wetland complex west of I-94.

Three small (1 to 2 acre) forest and emergent vegetation wetlands are located within a half mile east, south, and southwest of the site, but are unlikely to receive site-related contaminants.

The Beaubien Preserve has approximately 0.8 mi frontage of temporarily and seasonally flooded deciduous forest and emergent vegetation wetlands along the opposite bank of the Little Calumet River immediately downstream of the site. Another small (20 acre) temporarily flooded mixed forest and emergent vegetation wetland is near the river by Altgeld Gardens, west of Beaubien Preserve. This wetland is not shown as directly fronting the river, and is classified as having partial drainage. The next closest wetlands along the river are two deciduous forest palustrine wetlands almost 3 miles downstream. One, with about 0.14 mi river frontage, is on the north bank between the river and the rail spur south of 127th Street, and is temporarily flooded. The other, with approximately 0.5 mi river frontage, is on the south bank west of the rail bridge, part of the Whistler Preserve, Cook County Forest Preserve District, Riverdale, and is seasonally flooded.

1.1.3 Endangered Species

Lake Calumet is about 2.5 mi north of the landfill (about 3 mi upstream). It is unlikely to receive contaminants from the landfill, but is significant in that it contains black-crowned night herons, double-crested cormorants, great egrets and great blue herons. The former three species are listed as state threatened. The foraging distance of great blue herons ranges from 1 to 5 mi or more (USEPA 1993), and therefore may include the Little Calumet River adjacent to and downstream from the landfill. The same is probably true of the other species. Other state-listed birds at Lake Calumet include common moorhens, pied-billed grebes, least bitterns, black tern, and yellow-headed blackbirds.

1.2 Chemicals of Potential Ecological Concern

1.2.1 Chemicals at the Site

Soil, sediment, surface water and groundwater were sampled July 28-29, 1993, for the ESI. The chemicals elevated above background concentrations are as follows (the number following the medium is the total number of samples excluding background, and the number following the chemical is the number of samples with detections exceeding background):

Soil (4) - chloromethane (1), acetone (1), styrene (1), aroclor-1260 (1), Al (1), Ba (2), Cd (2), Ca (1), Cr (3), Cu (1), Fe (1), Pb (1), Mg (1), Mn (2), Ni (2), Ag (2), V (1), and Zn (1);

Sediment (10) - phenol (1), fluorene (1), phenanthrene (1), anthracene (1), fluoranthene (1), benzo(a)anthracene (1), bis(2-ethylhexyl)phthalate (BHEP) (1), 4,4'-DDD (1), 4,4'-DDT (1), Al (5), Sb (2), Ba (5), Be (3), Cd (3), Cr (6), Co (5), Fe (3), Ni (4), K (2), Tl (2), and V (5);

Surface water (2) - none;

Groundwater (3) - none.

Al, Ba, Be, Co, Fe, K, Tl, and V are eliminated from further consideration in soil, sediment, or both because the detections are below the approximate 95th percentile concentrations for soils in the eastern United States (Table 1).

Table 1. Elements Detected in Concentrations Equivalent to Literature-Reported Background and Therefore Eliminated as Chemicals of Potential Concern, Cosden Oil and Chemical Co., Calumet City, IL.

Element	Medium	Maximum Detection	Approx. 95th Percentile ^a
		———— mg/kg ————	
Aluminum (Al)	sediment	43,100	100,000 ^b
	soil	21.8	
Barium (Ba)	sediment	124	1500 ^b
	soil	216	
Beryllium (Be)	sediment	1.5	3.5
Cobalt (Co)	sediment	11.8	39
Iron (Fe)	soil	51,700	100,000 ^b
Potassium (K)	sediment	1460	27,000 ^c
Thallium (Tl)	sediment	0.38	1 ^d
Vanadium (V)	sediment	73.7	270
	soil	58.4	

a) Approximate 95th percentile in eastern United States soils calculated as geometric mean x (geometric deviation)² (Shacklette and Boerngen 1984), except where otherwise noted. The term "approximate" is used because the equation is based on a two-tailed distribution.

b) Maximum concentration in the eastern United States is used because the approximate 95th percentile value exceeded the maximum.

c) Approximate 95th percentile in eastern United States soils calculated as mean + (2 x standard deviation) because the distribution is normal (not log-normal) (Shacklette and Boerngen 1984).

d) Upper range of values commonly found in topsoils (Kabata-Pendias and Pendias 1992).

1.2.2 Fate, Transport, and Ecotoxicity

[this section is preliminary and incomplete]

Only those chemicals likely to contribute to the potential ecological risks of the site are discussed in this section. This procedure is followed because the preliminary ecological risk assessment (PEA) is based on a screening comparison of the concentrations of chemicals of potential concern (COPC) with benchmark guidelines by media. The benchmark values are sufficiently conservative so that chemicals detected at concentrations below the guidelines are not expected to exhibit significant ecological effects, even if fully bioavailable. Since fate, transport and toxicity variables do not modify the outcome of the screening (their effects are embedded in the derivation of the particular guidelines), discussions of these processes for the chemicals screened out are unlikely to contribute meaningful information to the PEA.

The following COPCs may contribute to the potential ecological risks of the site:

The toxic effects of chromium (Cr) are primarily expressed at the lower trophic levels. Cr may bioaccumulate in algae, other aquatic vegetation and invertebrates, but it does not biomagnify. Cr inhibits growth in duckweed and algae, reduces fecundity and survival of benthic invertebrates, and reduces growth of freshwater fingerlings. It is carcinogenic, teratogenic and mutagenic (Eisler 1986). Cr exists in two oxidation states in the environment: trivalent (+3 or III) and hexavalent (+6 or VI), the latter of which is more toxic. The majority of Cr in aquatic environments is insoluble and ultimately deposits in sediments. The soluble fraction is primarily Cr (VI). Cr (VI) is rapidly reduced to Cr (III) in anaerobic conditions, but the process is slow in aerobic conditions. Cr (III) predominates in deep (anaerobic) groundwater, and Cr (VI) predominates in shallow (aerobic) aquifers (ATSDR 1993). Cr (VI) is readily converted to Cr (III) in animals, which appears to protect higher organisms from the effects of low level exposures (Eisler 1986). The main potential ecological impacts result from direct exposure of algae, benthic invertebrates, and embryos and fingerlings of freshwater fish and amphibians to Cr. Potential endpoints include growth reductions and impaired survival.

Copper (Cu) is a micronutrient and toxin. It strongly adsorbs to organic matter, carbonates and clay, which reduces its bioavailability. There is a moderate potential for bioaccumulation in plants and no biomagnification. Mammals are not as sensitive as aquatic organisms. The predominant mammalian effects include hepatic and renal toxicity, and fetal mortality (ATSDR 1990).

Nickel (Ni) mainly occurs in the environment in the divalent (+2) state, which is soluble and primarily partitions into solution; however, it also readily adsorbs to or complexes with particulate matter, which reduces its availability and results in sedimentation. It does not bioaccumulate in aquatic organisms to any significant extent. Ni stimulates algal growth in low amounts, but suppresses growth of sensitive species at concentrations as low as 20 to 50 ppb (Vymazal 1995). Ni damages gill tissues, which interferes with respiration, and may result in death, or, at sublethal concentrations, hypoactivity (reduced activity) (Heath 1987; Nath and Kumar 1989; Elligaard, et al. 1995). The major toxicological effects in mammals include hepatic and renal toxicity, and weight loss (ATSDR 1993). The main potential ecological impacts of the wetland contaminants result from direct exposure of algae, benthic invertebrates, and embryos and fingerlings of freshwater fish and amphibians to Ni. Potential endpoints include growth reductions and impaired survival.

Lead (Pb) is relatively immobile in moderately acidic to basic soils (pH >5-6) with soil organic matter (OM) contents of at least 5% due to sorption to OM, ion exchange with clays and hydrous oxides, chelation with humic

substances, and formation of insoluble organic lead complexes. Leaching is very slow except under acidic conditions (pH <4-6), or low OM content (<5%), or when Pb concentrations exceed the soil cation exchange capacity. The main loss of soil Pb is by erosion (ATSDR 1993). Soil Pb is relatively unavailable to plants, except under acidic conditions, and the majority of the absorbed Pb is retained in the root system. Phytotoxicity is rarely observed, probably because of the low availability to plants and internal immobility (Kabata-Pendias and Pendias 1992). The poor translocation of Pb to above-ground plant tissues also means that foliar herbivory is not a major route of exposure to soil Pb, and that plant growth will not attenuate soil Pb levels. Earthworms do not bioaccumulate inorganic Pb except under highly acidic conditions, so the main route of exposure for vermivores is incidental soil ingestion (including soil in the worm guts) (Beyer 1990). The toxicity of inorganic Pb to earthworms is low, with LOAELs greater than 5000 and 50,000 mg/kg soil for inhibition of reproduction and growth, respectively (Edwards and Bohlen 1992). Shrews accumulate Pb to a greater extent than voles or mice, and estimated Pb intake on contaminated sites may approach the LOAEL for rodent reproductive effects (low to mid 10s mg Pb/kg bw/day) (Shore and Douben 1994). Pb poisoning of birds has been associated with ingestion of lead shot and bioaccumulative organolead compounds, but not with food chain exposure to inorganic Pb. There are complex interactions with other contaminants and diet. Pb poisoning in higher organisms primarily affects hematologic and neurologic processes. Potential endpoints include growth reductions and impaired survival (Eisler 1988).

Zinc (Zn) is another nutrient that also possesses toxic properties through its effect on nucleic acid regulating enzymes. Although high levels of Zn are required for molting, excessive dietary Zn can result in loss of muscular control in waterfowl. Zn is relatively nontoxic to mammals (Eisler 1993). Cu reduces the toxicity of Zn in mammals (Eisler 1993). Although Cd is more toxic than Zn, the ecotoxicological effects of Zn/Cd mixtures is attributable to Zn when their concentration ratios are greater than 10:1 (Hopkin and Hames 1994).

DDD, a chlorinated hydrocarbon also known as TDE, was formerly sold in the U.S. as an insecticide, and is also one of the metabolites of DDT. DDD is persistent and lipophilic and therefore bioconcentrates, bioaccumulates and biomagnifies. Its water solubility is very low, and it strongly partitions to sediments where it may remain bioavailable for decades. DDD volatilizes from soil or water, but the rate is only one-fifth of that of DDT or DDE (the half-life of DDT in soil is estimated to be 100 d). DDT degrades to DDD under anaerobic conditions. DDD is a neurotoxin that affects the central nervous system by increasing neurotransmitter release, disrupting neural ion regulation, and inhibiting neural ATPase activities. Symptoms include excitability, tremors, convulsions and death. However, the acute toxicity to mammals is low (3400 mg/kg bodyweight oral LD₅₀ in rats) (Matsumura 1985). DDD is highly toxic to many benthic invertebrates including black fly larvae, amphipods, freshwater prawns, and *Daphnia* (LC₅₀s in the low ppb); and to several fish species including trout, bluegills, bass and walleyes (LC₅₀s in 10s of ppb) (Mayer and Ellersieck 1986). The chronic effects are of more significance for higher organisms than the acute effects. DDD was associated with complete suppression of breeding in western grebes for over a decade following applications to a lake for insect control (Rudd and Herman 1972). The mechanism of reproductive suppression has apparently not been investigated for DDD, but DDT has been shown to cause eggshell thinning and hormonal disruptions. DDD is also carcinogenic in rodents (ATSDR 1994).

DDT and its metabolite DDE are highly persistent and lipophilic compounds subject to pronounced biomagnification. The extremely low water solubilities result in strong adsorption to soil particles and very low leaching losses. The main physical causes of attenuation of soil DDT are volatilization (estimated half-life of 100

days) and erosion. Microbes biodegrade DDT to DDE and DDD under aerobic and anaerobic conditions, respectively. Both metabolites are more persistent than DDT. Plants absorb DDT and its metabolites from soil, but they are poorly translocated and remain primarily in the roots. Foliar herbivory is therefore not a significant route of exposure to soil DDT. The toxicity of DDT to earthworms is low (Edwards and Bohlen 1992), so bioaccumulation by earthworms is a significant route of exposure to vermivores and can result in lethal doses (Barker 1958). DDT and DDE are moderately toxic to rodents with oral LD_{50} s in the low to high 100s mg/kg bw. However, DDT is a cumulative poison, and the chronic lethal dose may be substantially less than the acute lethal dose, for example, the chronic minimum lethal dose in mallards is 50 mg/kg bw/day, only 2% of the acute LD_{50} (Tucker and Crabtree 1970). DDT is a neurotoxin that affects the central nervous system by increasing neurotransmitter release, disrupting neural ion regulation, and inhibiting neural ATPase activities. Symptoms include excitability, tremors, convulsions and death. Chronic effects are of greater significance for higher organisms than acute effects. DDT adversely affects avian and mammalian reproduction by eggshell thinning, infertility, and embryo- and fetotoxicity. The effects may be related to the estrogenic activity of o,p'-DDT and o,p'-DDE. DDT and DDE are also carcinogenic in rodents (ATSDR 1994).

1.2.3 Exposure Pathways and Potential Receptors

[complete later]

2. Preliminary Analysis of Ecological Risk

2.1 Ecotoxicological Benchmark Values

The preliminary ecological risk assessment (PEA) is based on a screening comparison of the concentrations of chemicals of potential concern (COPC) with benchmark guidelines by media. The following (nonregulatory) guidelines are used in this PEA:

Sediment - Ontario Provincial Sediment Quality Guidelines (Persaud, et al. 1993);

Soil - Netherland Soil Cleanup (Interim) Act (Beyer 1990), Soil Cleanup Criteria for Quebec (Beyer 1990);

2.2 Exposure Estimates

The PEA is performed with the following conservative assumptions:

Bioavailability - 100%, with the exceptions of the influence of sediment total organic carbon (assumed to be 1% in the absence of site-specific information);

Area use factor - 100%;

Contaminant level - maximum sample concentration.

2.3 Risk Characterization

Comparisons of the concentrations of chemicals of potential concern (COPC) with toxicological guidelines are given in Tables 2 and 3 for soils and sediments, respectively.

Toxicological benchmark values are unavailable for chloromethane, acetone, Sb, Ca, Mg, and Mn. Comparisons are made with literature-based eastern United States soil background concentrations for the elements lacking toxicological guidelines. The results show that 1 sample each of Ca, Mg and Mn, and 2 samples of Sb, are elevated above commonly occurring soil levels, but the comparisons do not indicate whether there are potential toxicological concerns associated with these levels. Chloromethane and acetone are unlikely to cause significant ecological effects because they are highly volatile and dissipate rapidly at the soil surface, and because they were detected above background in only one sample (i.e., they do not appear to be widespread contaminants at this site).

The results show there is pervasive, but generally low, contamination across the site by a few inorganics: Cd, Cr, and Ni. These elements marginally exceed the lowest levels of concern in the majority of samples in which they are detected. Sample results elevated above potentially severe levels of concern are limited to the western portion of the site, specifically Cd, Cu, Pb and Zn in the soil within the styrene monomer tank berms (SS01, in which chloromethane and acetone are also detected), and Cr, Fe, and DDT/DDD in ditch sediments south of the tanks (ST09 and ST11). Elevated concentrations of inorganics that lack toxicological guidelines occur in similar areas: Ca and Mg near the berms (SS03), Sb in the ditches south of the tanks (ST09 and ST10), and Mn in the drum storage area (SS02) near the aforementioned ditches.

Ca, Mg, and Mn are also nutrients, and are unlikely to present ecological problems in the limited areas where they are elevated. The same applies to the two samples with elevated iron (Fe). Antimony (Sb) is elevated above background in two samples - the ditch (ST10) and the nearby low-lying area (ST09). The potential ecological risks are difficult to evaluate because there is only meager ecotoxicological information for Sb, however, the levels will not cause phytotoxicity (Kabata-Pendias and Pendias 1992). The most sensitive route of exposure for animals appears to be dust inhalation. The site appears to be well-vegetated, so dust exposure is probably minimized.

Some of the detected contaminants appear to be unrelated to the site. Polycyclic aromatic hydrocarbons (PAHs, including fluorene, phenanthrene, anthracene, fluoranthene, and benzo(a)anthracene) exceed the lowest level of concern in 1 river sediment sample (ST01 at the northwest corner of the site), but are not elevated in any of the other sediment or soil samples, with the exception of the background river sediment sample (ST03) northeast of the site. The presence of PAHs in a background sample, and the absence of elevated PAHs in 2 other river sediment samples and all of the on-land samples, indicate that the PAH contamination at ST01 is likely to have originated from off-site activities.

Two other organic substances, phenol and BEHP (bis[2-ethylhexyl]phthalate), exceed the lower benchmarks at one sample each (ST05 and ST04, respectively). BEHP is a common laboratory contaminant, is also detected in the background sample, and is only elevated in a single site sample, so it is not considered further in this assessment.

Table 2. Comparison of Soil Contaminant Data with Nonregulatory Soil Quality Criteria, Cosden Oil and Chemical Co., Calumet City, IL.

Substance	SQC ^a		Maximum Detection ^b	Hazard Quotient ^c	
	B	C		B	C
	———— mg/kg ————			no units	
Chloromethane	unavailable		0.12	—	—
Acetone	unavailable		1.2	—	—
Styrene	5	50	0.82	0.2	—
Aroclor-1260 (PCB)	1	10	0.6	0.6	—
Cadmium (Cd)	5	20	66.4	10	3
Calcium (Ca)	32,000 ^d		148,000	5 ^e	
Chromium (Cr)	250	800	455	2	0.6
Copper (Cu)	100	500	2440	20	5
Lead (Pb)	150	600	1240	8	2
Magnesium (Mg)	26,000 ^d		96,000	4 ^e	
Manganese (Mn)	3790 ^d		4130	1 ^e	
Nickel (Ni)	100	500	135	1	0.3
Zinc (Zn)	500	1500	212,000	400	100

a) The Soil Quality Criteria (SQC) are based on the Netherland and Quebec soil guidelines (Beyer 1990), except where noted otherwise. Criteria B refer to moderate soil contamination that requires additional study. Criteria C refer to severe soil contamination.

b) ESI 1995.

c) Hazard Quotient (HQ) = maximum sample concentration ÷ SQC, which is rounded to one significant digit.

d) Approximate 95th percentile for eastern United States soil, calculated as geometric mean x (geometric deviation)² (Shacklette and Boemgen 1984). A literature-based background value is used because a risk-based criterion is unavailable.

e) This value is the ratio by which the maximum sample concentration exceeds the approximate 95th percentile concentration for eastern United States soil. It does not indicate whether the exceedance is toxicologically significant.

Table 3. Comparison of Sediment Contaminant Data with Nonregulatory Sediment Quality Criteria, Cosden Oil and Chemical Co., Calumet City, IL.

Substance	SQC ^a		Maximum Detection ^b	Hazard Quotient ^c	
	LEL	SEL		LEL	SEL
	mg/kg			no units	
phenol	0.005 ^d	—	1	200	—
fluorene	0.19	1.6 ^e	0.95	5	0.6
phenanthrene	0.56	9.5 ^e	4.5	8	0.5
anthracene	0.22	3.7 ^e	0.86	4	0.2
fluoranthene	0.75	10.2 ^e	2.7	4	0.3
benzo(a)anthracene	0.32	14.8 ^e	0.96	3	0.1
BEHP	2.0 ^d	—	6.7	3	—
4,4'-DDD	0.008	0.06 ^e	0.21	30	4
4,4'-DDT	0.007	0.12 ^e	0.31	40	3
Antimony (Sb)	2.9 ^f		36.5	10 ^g	
Cadmium (Cd)	0.6	10	1.2	2	0.1
Chromium (Cr)	26	110	134	5	1
Iron (Fe)	20,000	40,000	74,800	4	2
Nickel (Ni)	16	75	28.2	2	0.4

a) The Sediment Quality Criteria (SQC) are based on the Ontario Provincial Sediment Quality Guidelines (Persaud, et al. 1994), except where noted otherwise. Lowest Effect Level (LEL) refers to marginally polluted sediments in which ecotoxic effects become apparent, but the majority of sediment-dwelling organisms are not affected. Severe Effect Level (SEL) refers to heavily polluted sediments likely to affect the health of sediment-dwelling organisms.

b) ESI 1995.

c) Hazard Quotient (HQ) = sample concentration ÷ SQC, which is rounded to one significant digit.

d) SQC based on chronic toxicity to benthic aquatic life assuming 1% total organic carbon (TOC) (NYDEC 1993).

e) Assuming 1% TOC.

f) Approximate 95th percentile for eastern United States soil, calculated as geometric mean x (geometric deviation)² (Shacklette and Boemgen 1984). A literature-based background value is used because a risk-based criterion is unavailable.

g) This value is the ratio by which the maximum sample concentration exceeds the approximate 95th percentile concentration for eastern United States soil. It does not indicate whether the exceedance is toxicologically significant.

2.4 Uncertainty

Risks are intentionally overestimated by the conservative assumptions discussed in section 2.2, and by the use of generic benchmark values.

3. Conclusions and Recommendations

There is widespread but low-level contamination of soils and sediments with chromium (Cr), cadmium (Cd), and nickel (Ni). Although the concentrations of these elements exceed screening values, the exceedances, with one exception, are relatively minor and are unlikely to present significant risks to wildlife at the site. The exception is the soil within the berms surrounding the monomer tanks (sample SS01), which is heavily contaminated with several inorganics. Cd, copper (Cu), lead (Pb), and zinc (Zn) all exceed the severe contamination levels at SS01, but nowhere else on the site. The highest Ni concentration also occurs at SS01. The soil within the tank berms may therefore represent a localized risk to ecological receptors.

The moderately elevated PAHs along the river appear to be unrelated to the site.

There are single samples that show elevated levels of DDD/DDT (ST11) and phenol (ST05). They probably do not present significant risks to ecological receptors because of their limited occurrence. DDT would be a concern if it was moving off site in significant quantities, however, the ditch in which it was detected continues only a short distance to the west where it apparently ends. DDD/DDT were not elevated in either of the ditch samples taken further east, so they appear to be localized and reasonably immobile.

Antimony (Sb) can not be definitely assessed because of a lack of toxicological benchmark values. The exposure route of concern is dust inhalation. The level of vegetative cover may be the key variable in this regard.

I may be contacted at 6-7195 if you have questions or comments. Please fill out the attached evaluation form and return it to Steve Ostrodka, SRT-4J. The information is used to assess and improve our services.

cc: Steve Ostrodka, Chief, TSS
Bruce Sypniewski, Chief, RRS#2

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